

A Multi-faceted Evaluation of Parametric and Non-parametric Modelling in Complex Urban Infrastructure Design

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Abstract. This study conducts a comprehensive analysis of parametric versus non-parametric modelling approaches to urban infrastructure design. Employing a mixed-methods approach, it evaluates performance metrics such as precision, adaptability, and scalability. Findings suggest that parametric models offer superior adaptability in complex, data-driven environments, while non-parametric models excel in resource-constraint scenarios. These insights inform future integration strategies of these methodologies in sustainable urban engineering projects.

Keywords: Urban Infrastructure Design, Parametric Modelling, Non-parametric Modelling, Sustainable Engineering, Performance Metrics, Scalability, Complex Datasets

Introduction

In the realm of urban infrastructure design, the ongoing quest for methodological refinement underscores the critical need to balance innovation with sustainability. The engineering and architectural sectors are increasingly tasked with developing infrastructure that not only meets the aesthetic and functional demands of modern society but also adheres to rigorous sustainability standards. This challenge is compounded by the rapid urbanization trends predicted for 2024-2026, which demand scalable and adaptable design solutions. Parametric and non-parametric modelling have emerged as pivotal tools in this

context, each offering distinct advantages and limitations. Parametric modelling, known for its precision and adaptability, allows for the manipulation of complex datasets to generate optimized design solutions. Conversely, non-parametric modelling provides robustness in scenarios where data parameters are fluid or poorly defined, offering an alternative pathway to resource-efficient infrastructure design. This paper undertakes a multi-faceted evaluation of these competing approaches, scrutinizing their efficacy across varied urban infrastructure scenarios. The analysis is anchored on performance metrics such as precision, adaptability, and scalability, providing a nuanced understanding of each methodology's applicability. The structure of this paper is organized as follows: Section 1 introduces the fundamental distinctions between parametric and non-parametric modelling. Section 2 presents a detailed methodology for the conducted evaluation. Section 3 delves into the findings, interpreting the performance outcomes of each modelling approach. Finally, Section 4 concludes with strategic recommendations for leveraging these insights in the field of sustainable urban design.

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